THE IMPACT OF COMPUTERIZATION ON THE DESIGN OF ACCOUNTING SYSTEMS IN THE U. S. NAVY SUPPLY SYSTEM

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by

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CHAPTER I

INTRODUCTION

Statement of the Problem

There are ample assurances by many eminent authorities that the "computer age" is causing basic changes in the procedures and organization of management in the Department of Defense. As early as 1965, a Congressional report to the President of the United States on the Management of Automatic Data Processing in the Federal Government had much to say about the impact of automatic data processing on government operations. Since the Department of Defense uses almost 70 percent of the computers owned or leased by the Federal Government,[1] the comments in this report are certainly applicable to that agency:

> In the short span of a decade, the electronic computer has had an unprecedented effect upon the conduct of Government activities. Use of this equipment has enabled Government to carry out programs never before possible . . . .[2]
>
> . . . ADP equipment is increasingly becoming integral to the accomplishment of agency missions and, in certain instances, it is virtually synonymous with program accomplishment.[3]

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[1]U.S., Bureau of the Budget, Inventory of Automatic Data Processing Equipment in the Federal Government, June 1965, pp. 16-17.

[2]U.S., Congress, Senate, Committee on Government Operations, Report to the President . . . , 1965, p. 1.

[3]Ibid., p. 67.

Vice Admiral B. J. Semmes, Jr., Chief of Naval Personnel, in an address to the Armed Forces Management Association's Conference on changing patterns of Defense management, stated:

> Today, advances in management occurring through application of operations research techniques, and computer technology, have made it possible for the military manager to enter a new management era.[1]

The area of financial management has been affected by these basic changes. The new management organization must have a solid base of information. The tremendous costs associated with the technological revolution have increased the level of concern for accounting systems which will provide both financial and non-financial information to managers at all decision levels.

The Department of Defense operations have significant effects on the U.S. economy. Interest has been shown at the Congressional and Executive level to the extent that the President of the United States has directed the use of the Accrual method of accounting.

> The adoption by the Department of Defense of accounting and financial management systems more analogous to the commercial world increases the comparability of these two areas of endeavor. If present tendencies hold, there will continue to be attempts to incorporate the proven management methods of industry into the functioning of the Department of Defense. The use of business consulting firms to evaluate the procedures of the various services is an indication of this tendency, as is the appointment of major figures in the business community to high positions within the Department. This business rationale has modernized

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[1]Semmes, B. J., Vice Admiral. "Innovations in Navy Personnel Management," The Journal of the Armed Forces Management Association, II, No. 5 (1965), p. 49.

> some patently outdated procedures and introduced its share of confusion as well.[1]

The shift from manual records to bookkeeping machines to computers has revolutionized the field of accounting. It has also opened a Pandora's box of problems along with untold possibilities. It is the purpose of this thesis to examine these problems and benefits along with their possible solutions and applications.

Scope of the Investigation

The study will be primarily concerned with the accounting systems of the United States Navy Supply System. However, revelant information from the fields of Data Processing and Accounting external to the Navy will be introduced and evaluated.

The extent to which the Navy accounting system has been computerized will be assessed along with the attendant problems and benefits currently being realized. A look beyond the Navy systems will be made to determine the probable future obstacles and benefits which will be encountered. Solutions to present and foreseeable problem areas will be discussed and evaluated.

Methods of Research and Analysis

A combination of primary and secondary research will be employed. The primary research will be interviews with key personnel in the Office of Comptroller of the Navy and

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[1]Peter A. Duffy, "Controllership and Marine Corps Comptrollership: A Dual Survey" (unpublished Masters thesis, The George Washington University, 1970), p. 71.

the Navy Supply Systems Command. The interviews are intended to provide basic guidance into the problem areas as well as to provide complementary information for the secondary research. Reference documents will consist of Department of the Navy directives and publications, professional magazines and various textbooks. A report prepared by civilian contractors concerning their evaluation of the Navy accounting system will also be used. The method of analysis will be primarily deductive, applying general principles and ideas to particular Navy concerns.

Organization of the Study

Chapter II will define the nature and place of an accounting system within the total information spectrum. A basis for evaluation and rationale for computerizing the system will be given. An evaluation of the current status of the Navy accounting system will then be presented.

Chapter III will present and analyze typical benefits being derived from increased computerization both in Government and Industry. Particular attention will be given those potential benefits most likely to be achieved by the Navy system.

Chapter IV will examine existing and expected problem areas. The problem of auditing a computer system will be discussed at some length.

Chapter V will present an overview of the problems and benefits in these areas. Finally, the writer's conclusions and recommendations will be summarized.

Author's Disclaimer

This thesis represents the views of the author and does not necessarily reflect the opinion of the Department of the Navy nor any Command therein.

CHAPTER II

EXTENT OF COMPUTERIZATION OF ACCOUNTING

Defining the Optimum

The Deputy Comptroller for data automation in the Office of the Secretary of Defense has stated the need for a more quantitative approach to the management of ADP systems: "One of the first considerations is the documentation of a well thought out set of measurable objectives in which the system will be expected to meet. Along with this should be a delineation of exactly how these objectives will be measured and met."[1]

In keeping with the spirit of the above statement and to provide a framework for discussion, it is appropriate to ask some questions concerning the extent to which the Navy has computerized its accounting systems, i.e., To what extent should any accounting system be computerized? What do we mean by "accounting system" and where does it fit in relation to the total information system? In other words, what are the objectives of the accounting system, what are the objectives of computerizing the system, and what is the yardstick against which progress is to be measured?

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[1]Joseph B. Warren, Col. USAF, "EDP Scapegoat for Human Errors, Business Automation, Vol. 17, No. 10 (October, 1970), p. 51.

First, financial information systems have been defined by James B. Bower et. al. as

> a combination of systems components that function within the business organization to process data and to provide the information and internal control needed by management to carry out its responsibilities of stewardship over the assets, of control over operations, and to plan future enterprise activities. Its functions within the scope of systems principles and limitations of systems standards.[1]

Note the internal orientation of the above definition and consider the definition of financial accounting offered by Robert N. Anthony. "Financial accounting is the process of reporting financial information about the organization to the outside world."[2] Anthony states further that, "Since the management control process encompasses the totality of the organization, management control systems, with rare exceptions, have an underlying financial structure; that is, plans and results are expressed in monetary units."[3]

The confusion over the orientation of financial systems, internal versus external, is recognized by Anthony. This confusion is a contributing factor to a number of problems discussed later. For the purpose of this paper the definition given by Bower will be used.

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[1]James B. Bower, Robert E. Schlosser, and Charles T. Zlatkovich, Financial Information Systems: Theory and Practice (Boston: Allyn and Bacon, Inc., 1969), p. 8.

[2]Robert N. Anthony, Planning and Control Systems: A Framework for Analysis (Boston: President and Fellows of Harvard College, 1965), p. 22.

[3]Ibid., p. 41.

To properly fit the financial information system into the larger, total information system consider the nature of the larger system.

> The usual business information system is highly complex, yet extremely practical and logical. It consists of a combination of sub-systems and procedures, with the components of each interrelated to provide appropriate information and control measures for every segment of the business.[1]

The business information system developed out of the necessity to manage and control the organization.

> Early business information systems were limited to the information processed through accounting systems. Until recently such systems were designed almost exclusively for the processing of historical facts necessary for traditional financial statements.[2]

The constantly increasing tempo of operations, competition, and the sometimes incredible complexity of modern business of operations is causing a reexamination of the role of information systems in modern management.

> In recent years business information systems have been designed to provide more and more quantitative information, including detailed facts about markets, production, and financial matters. Business managers in the past have often considered the system as a necessary evil, and did not utilize it as a useful tool to accomplish their own function of managing the business. For modern management, a broadly based, efficient, and effective system is essential.

Further,

> Modern businesses are moving toward adoption of business information systems that function as a total information system. The total information system concept is based on the premise that each business

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[1]Bower, Financial Information System, p. 4.

[2]Ibid.

> is a complete system in itself. It is a highly interrelated and complex maze of sub-systems and procedures.
>
> Ideally, each sub-system or procedure processes data and provides internal control in such a manner as to require the input of specific data into the system but once. Thereafter, the system can be called upon to provide the original data and/or information from subsequent processing, depending on the particular needs. The inefficiency of bringing the same data or information into the system more than once is avoided, and the advantages of multiple data and information use and of the automatic sequencing of signals for action can be realized.[1]

Implicit in the above is the idea that certain financial information is inseparable from the non-financially quantified data inherent in the transactions or operations being recorded. That is to say, all the information concerning a transaction should be entered into "computer files once and only once, and from there all other affected records should be updated and the appropriate actions triggered."[2]

> Management control systems are, or should be coordinated, integrated systems; that is, although data collected for one purpose may differ from those collected for another purpose, these data should be reconcilable with one another. In a sense, a management control system is a single system, but it is perhaps more accurate to think of it as a set of articulated subsystems."[3]

The following note will suffice to summarize the objectives of the accounting system:

> Every business must have a financial information system to fulfill three specific needs. First, the

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[1] Ibid.

[2] Leonard I. Krauss, Computer-Based Management Information Systems (USA: American Management Association, Inc., 1970), p. 20.

[3] Anthony, Planning and Control Systems, p. 42.

> system must provide for the internal informational needs of management. Second, the system must provide management with a means of measuring and controlling business activity. Lastly, the system must provide for the external informational needs of management.[1]

Several reasons could be advanced for computerizing the accounting system. The most obvious reason is that the computers are, in most cases, already available in the Navy supply system. "The largest group of computers devoted to a single function is in logistics, for the management and control of the supply, transportation, and maintenance functions throughout the (Defense) Department. This accounts for over 26 percent of the Department of Defense computers."[2] Considering the above-mentioned interrelationships of the subsystems, it would appear that the majority of the data base required to drive the accounting system is already in the computers, although not necessarily in financial terms or in a form that could be immediately useful to financial accounting.

Bower has said that,

> The complexity of a business information system depends on the needs of management. The needs of management for information and internal control are a function of the size geographical diversification, and the nature of the business activity.[3]

It would thus appear that the management needs of the U.S. Navy are sufficient to justify a complex information system.

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[1]Bower, Financial Information Systems, p. 10.

[2]Warren, Business Automation, p. 47.

[3]Bower, Financial Information Systems, p. 6.

Chapter III will examine more comprehensively the benefits possible through the use of computers which would strengthen the argument for computerization.

Two questions now arise: to what extent should computers be employed, and how does one measure progress toward the optimum once it is defined?

Measuring the Progress

It was stated above that the first consideration in developing a more quantitative approach to ADP management is a set of measurable objectives. The major objectives for an accounting system were summarized as fulfilling three specific needs; internal information for management, a means for management to measure and control activity, and external information needs.

The next consideration in a quantitative approach is the measurement of costs, i.e.,

> to identify all resources which will be assigned to this discrete project. These resources take the form of such things as salaries, man-hours, contracts and computer time. Once we have put a bound on the project and the assigned resources, the next step is to perform a classical economic analysis to determine the cost-effectiveness of that which is being proposed. The full cost and the attendant benefits should be revealed. If the venture is in fact cost-effective, there is little question as to approval to go forward. If the venture is not cost-effective, the approving authority should have the cost of the approval decision known to him, and make his decision in full knowledge of this, and have this decision documented. This does not mean that every decision must be cost-effective, but it does mean that decisions in this area must be made

> in an environment where all known facts that bear on the case are revealed.[1]

It is significant that Colonel Warren chose cost-effectiveness as the decision criterion rather than cost benefits. Robert H. Haveman has this to say about the difference between cost-effectiveness and cost-benefit analysis.

> Where the conceptual problems of defining this output and establishing its value could be solved, analysts calculated ratios of benefits to costs . . . .
>
> In those cases in which the program output was difficult to define or measure or where the output could not be valued, analysts performed what is called cost effectiveness analysis. [italics mine][2]

Since the value of information, like beauty, is largely in the eye of the beholder, it is difficult or impossible to determine objectively. Thus, cost-effectiveness is the proper criterion for judging ADP information systems.

Mr. John Carabello of the Office of the Secretary of Defense supplies some additional guidelines for answering the "how much" question.

> DOD is in business to guarantee national defense and maintain fighting forces, not maximize ADP facilities. Therefore, the valid test of ADP effectiveness is the extent to which it supports mission-oriented objectives and attendant forces and programs. While it may complement some forces and serve as a trade-off with others, it is a means to an end and not an end in itself.[3]

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[1]Warren, Business Automation, p. 51.

[2]Robert H. Haveman and Julius Margolis, ed., Public Expenditures and Policy Analysis (Chicago: Markham Publishing Co., 1970), p. 6.

[3]John M. Carabello, "Examining the Cost/Effectiveness of Automated Data Systems," Armed Forces Comptroller, Vol. 16, No. 4 (Fall 1971), p. 10.

Bower and others have stated essentially the same idea of justifying the system by the contributions it makes to enable effective management.

> It should furnish timely information to management, setting the stage for good decision making. A successful business information system contributes materially to better service and better management, and provides a vigorous environment for the accomplishment of business goals and objectives.
>
> Management expects its business information system to provide the information and control facts and procedures necessary for the accomplishment of its objectives. The system must provide information concerning historical costs and profitability. Periodic performance reports, covering all areas of responsibility, must be available. Such reports provide identification of strengths or weaknesses in the present position, and the magnitude and priorities of future tasks.[1]

Leonard I. Krauss takes the idea one step further. He states:

> The test of the new system is not data cost but data value. The proof of data value is no longer found in the reduction of administrative personnel, but in the profitable utilization of highly qualified middle management people . . . . The design and development of this new data system must serve value creation first and cost reduction later.[2]

In referring to the elementary application of the 1950's and early 1960's, Krauss observes the following: "The value of the computers, when it was measured at all, was calculated by the rather primitive methods of cost displacement of clerical and machine resources." In the more recent applications, ". . . the computer is beginning to effect change not

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[1]Bower, Financial Information Systems, p. 5.

[2]Krauss, Computer-Based Management Information Systems, p. 12.

only in how a business operates but in what it does. Supervisory management is undergoing transformation in all the basic areas of corporate activity. Measurement by cost displacement has already become obsolescent."[1]

Thus it may be concluded that a computerized accounting system must be justified by weighing the cost of the system against the non-quantifiable benefits which support "mission oriented" objectives. Since the system cannot encompass the entire Department of Defense mission, it must be determined whether to support the operator or the accountant. That is to say, should the system be primarily a tool for top management to use in meeting the external reporting and budgeting requirements or should the system primarily support the manager of the local activity in his day-to-day operations. Bower by his placement of the order of specific needs implies his preference for the latter orientation.[2]

It is the writer's opinion that pressures on top management have forced an orientation toward the external and top level requirements at the expense of the internal managers. This point will be developed in more detail later.

Examining the Current Status

We have seen that the optimum utilization of computers is that level which meets the objective as stated above, using the system which is most cost effective.

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[1] Ibid., p. 13.

[2] Ibid., p. 10.

Because of the value judgments inherent in setting each element of costs and effectiveness, it is difficult if not impossible to quantify either the optimum level of computerization for the Navy accounting systems or to quantitatively measure the level presently achieved. At this stage in the evolution of computerized information systems, in the Navy as well as in industry, information requirements both internal and external are only vaguely defined, seldom articulated, and constantly changing. Devices for measuring and controlling activity are especially troublesome to develop in a non-profit environment such as the defense establishment.

According to one authority who is intimately involved in the Navy supply accounting system development there is no way to define the extent of computerization which now exists in the Navy accounting system. All systems and all appropriations are computerized in some form at some level.[1] There are varying degrees of computer use within systems between different activities of the same type, and varying degrees of system development between the various appropriations.

It is apparent from a perusal of various internal memorandums and reports that the criterion of cost effectiveness is widely used in designing the system and that the planners are conscious of the Navy-Wide implications of the various proposals.

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[1]C. P. Herrin, Head of Accounting Systems and Procedures Branch, Navy Supply System Command Headquarters, private interview, 6 Jan. 1972.

A recent report prepared for the Deputy Comptroller of the Navy by the CPA firm of Haskins and Sells outlined numerous organizational and systems development problems. These indicate that while progress is being made, some level of development far short of the optimum has been achieved. Significant findings include a need to strengthen centralized direction over accounting systems development and thereby achieve a better "total system" perspective.[1] A number of minor findings indicate to this observer a need for a greater orientation toward the internal management needs at lower levels. The report noted "little evidence of the use of automatic data processing"[2] in handling the substantial detail involved in the budget formulation process.

Summary

This chapter has been concerned with establishing a framework for discussion of the impact of computerization on the accounting systems of the Navy. The objectives of the accounting systems were established as providing information to meet three specific needs: internal management information, a system to measure and control business activity, and external information. Emphasis is placed on the first of the three needs as being the primary objective. The nature of the total information system was considered to bring proper focus to the

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[1]Haskins and Sells, report of results of a study of the Navy Department's accounting system, September, 1970, p. 16.

[2]Ibid., p. 159.

position which accounting holds, or should hold, in that larger system.

The rationale for computerizing the accounting system was examined and guidelines for evaluating the extent to which it should be computerized were discussed. It was determined that absolute quantification of the optimum is not possible nor is an accurate quantitative measurement of the present status of computerization. The value of the costs and effectiveness of the system are necessarily value judgments as are the management needs which the system should meet.

The Navy accounting system is undergoing rapid change, goals and methods are being reevaluated.

The technological revolution experienced in military hardware and operating systems have generated a scale of operation and a pressing need for new and better accounting and management techniques. The first steps have been taken, however the system is now less than optimum. The following chapters will explore in greater depth the possibilities and problems visible on the horizon.

CHAPTER III

ANALYSIS OF BENEFITS

General

It is the purpose of this chapter to survey the benefits reasonably expected from computerization of the Navy accounting system. A review of the benefits being realized or being anticipated by authorities in the field will be made. Many of the authorities cited are referring to civilian application, however the assumption is made that similar benefits would accrue to military applications. The primary factors that differentiate military and civilian applications, insofar as management in a computer environment is concerned, are size, complexity, and special problems common to the public sector of the economy.

Charles J. Hitch and Roland N. McKean have observed that the efficient use of resources in government is a special problem because of "the absence of any built-in mechanisms like those in the private sector of the economy, which lead to greater efficiency. There is within government neither a price mechanism which points the way to greater efficiency, nor competitive forces which induce government units to carry out each function at minimum cost . . . . The role of systematic quantitative analysis in military decisions is potentially

much more important than in the private sector of the economy."[1]

To facilitate discussion, the potential benefits may be divided into two general categories: lower costs and better management. These categories are admittedly arbitrary and not mutually exclusive. The two areas will be treated in subsequent sections. A word of caution is appropriate at this point. In a prolonged discussion of benefits, it is easy to forget the consequences. For every job "saved" by using the computer there is a person without a job to do. An increase in centralization of control produces a feeling of loss of control in the field managers and creates its own set of problems. In other words, computers are not a panacea for problems, nor is their use a guarantee for successful management.

Lower Costs

Costs are among the first considerations in the decision to adopt a new system or project. The outlay necessary to get the system in place and in operation must be determined. Certain offsetting benefits generally are projected and quantified as much as possible. The impact of these benefits on the organization are relatively easier to see than are the secondary problems they sometimes create. This section will survey the direct benefits usually derived from the use of computers. The

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[1]Charles J. Hitch and Roland N. McKean, The Economics of Defense in the Nuclear Age (Forge Village, Massachusetts: The Murray Printing Company, 1960), pp. 105-107.

next section will deal with the less direct and less tangible benefits in the "better management" category. Chapter IV will treat the problems created by the change.

Usually the first "savings" to appear, and often the most controversial, are those which effect the people involved. One student at the Industrial College of the Armed Forces, in investigating the changing roles of Defense managers in the computer age concluded that "the most apparent impact of the 'computer age' has been in the reduction of people in the industries that have been automated." He cites numerous industries which have experienced rapid decline in the number of "blue collar" workers employed while production continued to increase.[1] A significant factor in this trend is the use of computers. "The United States Information Agency has estimated that on the average every electronic computer puts 35 people out of work and changes the kind of work for 105 additional workers."[2]

This reduction in production workers has reduced to some degree the number of middle managers required. However, more significant to middle management is the fact that "many of the present decision-making activities of middle managers

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[1]John D. Longhill, Lt.Col. USAF, "The Changing Roles and Responsibilities of Defense Managers in the Computer Age" (unpublished Thesis, Industrial College of the Armed Forces, 1965), p. 28.

[2]U.S. Information Agency program quoted by Roscoe Drummond and Samuel Zagovia, "Cybernation Growth Has Woes, Too," The Washington Post, November 15, 1965, p. O-10.

are capable of being programmed, in the sense that specific procedure can be written in language understandable by computers, which can then perform the necessary operations electronically and tell the manager what is the optimum course of action."[1]

Not only has the number of production workers and middle managers been reduced, but the nature of the jobs has changed as well. Prior to mechanization, the accounting process was characterized by extensive files of contracts, invoices, shipping documents, and payment vouchers. Visual matching of related documents and hand annotation was required in processing each transaction. The ability of the computer to mechanically "match" the various documents and update a master record has eliminated the need for progressive hand annotation of documents.[2]

Maintaining the document files in a computer accessible form such as magnetic tape permits the combining of two or more "files" into more comprehensive records. This often eliminates the need for overlapping and duplication of files and the constant need for reconciliation of the data between files.

The broader, more comprehensive records can provide more complete and meaningful information to users. If timely access to the files is provided, many of the memorandum records

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[1]Neil H. Jacoby, "Impacts of Scientific Change Upon Business Management," California Management Review, IV, No. 4 (Summer 1962), pp. 36-37.

[2]C.P. Herrin, interview.

now extant could be eliminated. All of these benefits--reduced personnel, eliminated file duplication, eliminated memorandum records, and simplified processing can result in substantial savings.

Better Management

It has been suggested by at least one observer of the "computer age" that "possibly one of the least recognized, but nonetheless important, contributions of the 'computer age' to management is that, through the computer and its attendant quantitative methods, the manager now has the capability to treat his organization as a complete, integrated whole (system concept) instead of as departmentalized, functionally separated segments."[1]

This new-found capability has been brought closer to actuality by a trend (in military operations) toward centralization of decision making. This centralization would not have been possible without the computer capability. John Diebold has pointed out:

> Management has a capacity never possible before either to centralize or decentralize its decision functions . . . . Whether or not centralization is appropriate will vary with the situation, but the decision need no longer fall automatically to decentralization.[2]

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[1]Longhill, p. 30.

[2]John Diebold, Beyond Automation: Managerial Problems of an Exploding Technology (New York: McGraw-Hill Book Co., Inc., 1964), p. 25.

In the opinion of Charles J. Hitch, centralization was appropriate for the planning, programming, and budgeting process in the Department of Defense. He has stated: "Considering the vast quantities of data involved in the planning-programming-budgeting system, the only practical solution was to transfer the entire operation to a computer system."[1]

Mr. Hitch justified the use of the computer by the vast quantities of data involved. A certain degree of centralization is implicit in the use of computers.

Haskins and Sells see several benefits possible through centralization of certain parts of the accounting system. A major recommendation of their study of the Navy accounting system is to "achieve an 'Integrated Accounting' posture that realigns the flow of data; combines accounting and disbursing activities organizationally and geographically; and reduces time-lag, error and reconciliation problems."[2] Other benefits expected from the "Integrated Accounting" posture are: concentration of available talent now dispersed among activities, and reduction in the need for memorandum records as a result of improved accuracy and timeliness of information to management.[3]

It was also pointed out that Integrated Accounting would provide "a means by which accrual basis accounting can

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[1]Charles J. Hitch, Decision Making for Defense (Berkeley, Calif.: University of California Press, 1965), p. 24.

[2]Haskins and Sells, p. 22.

[3]Ibid., p. 60.

be provided as a by-product of processing, thus not requiring special analysis or handling."[1]

A final benefit visualized by Haskins and Sells is "establishing the means by which output measurement data can be matched, reported, and summarized along with appropriate accounting data."[2] The area of output measurement and resultant ability to improve management control was discussed by Paul Kircher in a research report at the University of California several years ago. His observations are still considered to be valid.

> The truly important features of the new equipment is the promise that it holds forth for the development of new and much more effective controls of performance than we have hitherto been able to achieve.
>
> There are two phases of this problem of control. The first is the establishment of norms, or standards, and allowable deviations from these standards. The second is the reporting of actuals, comparison with standards and reporting of significant variances of executive action.
>
> In order to establish useful standards we should be able to employ the computing mechanisms to gather data faster and more completely than is at present possible. We then should be able to treat the data with more advanced statistical techniques, by using the already developed mathematical abilities of the computer.[3]

The new management capabilities offered by the computer are affecting the accounting systems of the Navy. "The trend is toward greater centralization of the mechanics of accounting.

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[1] Ibid.

[2] Ibid.

[3] Paul Kircher, "The Gap Between the Electronic Engineer and the Accountant" (unpublished Research Report, University of California, Los Angeles, December 3, 1953), p. 9.

Fewer activities are actually doing the accounting. The acceptability of mechanized records, once validated and submitted by a satellite activity, permits each accounting activity to cover a larger geographical area."[1]

Summary

This chapter has briefly surveyed the benefits normally experienced from the use of computers in accounting. The first area of benefits considered are those of cost displacement, i.e., reduced production workers, reduced number of middle managers and the changed roles of those left. Non-personnel benefits included reduced duplication of document files, better and more comprehensive information available to managers with consequent reduction of the need for local memorandum records. As has been stated in Chapter II, this area was the primary justification for computers in the 1950's and early 1960's. The more sophisticated approach used today considers the increased value of the system to management, rather than the costs displaced by it. The cost-displacement benefits are still important, however, as they affect the first (cost) element of the cost-effectiveness analysis by which the system is to be judged.

The "effectiveness" element of the analysis was surveyed. Among the benefits which increase the value of the system were the capability to treat the whole organization, the capacity to permit greater centralization through the use of

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[1]C. P. Herrin, interview.

computers, and the numerous benefits which accrue through greater centralization of accounting. Evidence from those involved in the current Navy system indicates that the capacity to centralize and the capability to consider the total Navy-wide system of accounting is being utilized. The trend is toward centralization.

Nothing is free and the above-cited benefits are no exception. Chapter IV will consider some of the many problems and implications which have inevitably accompanied the changes wrought by computerization.

CHAPTER IV

ANALYSIS OF PROBLEM AREAS

An Extra Dimension

The literature of comptrollership is replete with the exhortation to insure congruence between the objectives of the accounting and control system and those of the organization being served. One broad objective common to both public and private enterprise is the efficient use of resources. However, there are special problems associated with the use of resources in the public sector which compound the allocation problem. Charles Hitch and Roland McKean have identified the problem as: "The absence of any build-in mechanisms, like those in the private sector of the economy, which lead to greater efficiency. There is within government neither a price mechanism which points the way to greater efficiency, nor competitive forces which induce government units to carry out each function at minimum cost."[1] The lure of profits and the threat of bankruptcy forces private firms to seek profitable innovations and efficient methods. Government has no profit lure and promotions of personnel do not depend on profits. Incentives to choose efficient methods over the personal whim of officials are not strong because the costs of choosing inefficient policies do not impinge upon the

[1]Hitch and McKean, The Economics of Defense, p. 105.

choosers. Government competes only with the political party that is out of office and survival in this competition depends upon many factors other than efficiency in the use of resources. "Thus there is neither an adequate price mechanism to reveal the cheapest methods of performing public functions nor any force which induces or compels the government to adopt such methods."[1]

"The dichotomy of mission between a service within the Department of Defense and a large manufacturer of automobiles produces a difference of attitude and purpose among the individual members of each organization that surpasses the variation in their chart of accounts . . . . The return to the public that the service seeks is largely an intangible commodity: maximum combat effectiveness, judicious use of available funds, optimal training and readiness, etc., different goods to measure . . . . These divergencies of philosophy and objective are a vital consideration in the comparison of the financial management function between a service and any individual concern."[2]

The problems of efficiency measurement and the motivation of management to seek efficient solutions to problems is indeed a problem area worthy of analysis, however to do justice to the analysis would require time and space beyond the limits of this thesis. They do, however, indicate the nature of the

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[1] Ibid., p. 106.

[2] Peter A. Duffy, "Controllership and Marine Corps Comptrollership: A Dual Survey," pp. 68-69.

management environment in which the accounting system must function. Specifically, the lack of a profit motive, or competition, and the intangible nature of the Navy's "output" brings an additional dimension to all of the problem areas which will be discussed in this chapter.

A Specialization Gap

That the interface between the computer specialist and the accountant is critical to the successful design and operation of any computer based accounting system is obvious. "Since the need for an ADP system is premised upon improving mission-oriented forces and programs, its cost-effectiveness analysis, development and implementation should evolve from continuous interaction between the users and the designers . . . . In most cases, unless the analyst goes beyond the bounds of ADP to show the impact on the mission-oriented program supported by that ADP, he will have a difficult time trying to identify a benefit sufficient enough to justify the cost of the new equipment."[1]

Two elements to be considered in the interface are the communication channel through which the players interact, and the understanding of what constitutes "mission orientation" in the accounting system.

To consider first the communciation channel, it appears from the literature in the field that more accusations and counter-accusations have been made than have constructive efforts at bridging the gap.

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[1]John M. Carabello, "Examining the Cost/Effectiveness of Automated Data Systems," p. 10.

Computer specialists are often accused by accountants of lacking appreciation for the necessary controls against fraud, embezzlement, and in the case of government accounting, many legal requirements imposed on the accounting system.

Accountants, in turn, are accused of living in the past, of taking a "green eye shades" viewpoint, and failing to appreciate the computer capabilities. Harold Weiss, in concluding a recent article which reported the Second Advanced E. D. P. Audit and Control Conference states:

> . . . it would appear that the auditing profession is still lagging computer developments by 5 to 10 years, although the sophisticated use of computers for auditing goes back at least to 1955. There are only a few experimental efforts by auditors to cope with the new real time systems and to develop more sophisticated and efficient audit techniques. Not many internal auditors were on the program despite efforts of the sponsor to involve them.[1]

Why would auditors be reluctant to participate on the program? Perhaps some of the reasons are to be found in the work of Paul Kircher, written from an accountant's point of view and directed at the need to overcome the "gap" and prepare accountants and the accounting world for the new electronic environment in which they operate.

> When we try to find out more by turning to our friends the electronic engineers, we are met by talk of tapes, drums, random access times, memory units, programming--all of which is most interesting. But the question remains, What do we do now? We can't help with the electronics. How can we prepare, not in general terms, but for an application in a specific business?
>
> At the moment, accountants and electronic engineers would seem to have similar objectives. If these machines

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[1]Harold Weiss, "Computers and Auditing," Datamation (July 15, 1970), p. 113.

> will indeed be useful, we both are interested in hastening the day, in making the necessary preparations, which everyone agrees will have to be extensive. Yet it seems apparent that with a few exceptions there is a serious lack of communication between the two parties.[1]

Why should this gap exist?

> Again, the major reason appears to lie in the history of the development of computers. For the most part they have come as a result of government sponsored research, the efforts of smaller companies and universities to produce machines that will make mathematical calculations, especially those required for various phases of national defense. As a result the experts in the field are drawn from the ranks of mathematicians and electronic engineers.
>
> Even now a major manufacturer of office equipment is conducting a school to educate businessmen in the use of their computer. The faculty is made up of mathematicians and engineers.
>
> Most workers in the field know that a computer which is designed to do mathematical work must be 'stood on its head' to be ready for accounting applications. Where mathematics generally calls for relatively few inputs, modest internal memory, few outputs, but rapid calculation, the accounting demand is almost exactly the reverse. Much ingenuity has been concentrated on the engineering problems of getting more input, more output, and much more storage.
>
> But this is only part of the difficulty. The other part, which becomes more serious as the engineering problems are overcome, stems from the fact that accounting routines are not at present suitable for immediate conversion to the electronic techniques.
>
> This problem, equally if not more serious than the former, is not receiving nearly as much attention. At least this is the impression gathered from a rather extensive survey of literature in the field, and from consultations with experts attached to various computer companies.

Thus the preoccupation of computer specialists with mathematics, engineering, hardware and the related devices that make up their world is seen as one of the obstacles to the better communications necessary for better design and operation of computer-based accounting systems. Not all of the blame should

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[1]Paul Kircher, "The Gap Between the Electronic Engineer and the Accountant," p. 6.

[2]Ibid.

be attributed to the computer specialists. The editor of Business Week magazine points to the accountant as part of the problem. He states, "the Accountant does not communicate clearly to the non-accountant . . . a great many accountants either do not really understand the theoretical basis of accounting or talk as if they don't. Consequently, they cannot explain what they are doing in terms that make sense to anyone but another accountant."[1]

The gap between the two fields is considered a major deterrant to progress on many fronts. But what can be done to close the gap?

> Neither side is likely to make progress by itself. There is too much to be learned in each field for many individuals to become experts in both. For this reason a team approach usually will be necessary. But before a team can operate it is necessary that the members have a certain account of common understanding, an appreciation of the importance of the other fellow's contribution and a knowledge of the language he uses . . . . In the last analysis, it is the responsibility of top executives to bring the accountants and engineers together, to encourage them to close the gap which exists between them. We must build a bridge between the two fields so as to further progress in this field.[2]

A brief consideration of the second element in the user-designer interface, that of mission orientation is necessary at this point. Permeating the thoughts of both the users, designers and the decision makers who must finally approve the system should be a common agreed upon base of what constitutes

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[1]John L. Cobbs, "How the Business Press Views the Accounting Profession," The Journal of Accountancy, August, 1969, p. 49.

[2]Paul Kircher, "The Gap Between the Electronic Engineer and the Accountant." p. 12.

the mission. We have already commented on the fact that historically accounting systems have been more tolerated than appreciated, a necessary evil in the running of a business. Unfortunately many of us tend to put white collar workers in general in the same category, that of overhead, non-productive labor. Yet, as Dr. Adrian McDonough has observed in an address to the Industrial College of the Armed Forces, over 52 percent of our labor force is white collar. We must change our thinking because we have a subconscious guilty conscience that over half of us are not producing. We must change our thinking in terms of what is production. Specifically, we must recognize that the Navy supply system's mission is more than getting the right material to the right people at the right time. It is also our mission to account for that material both quantitatively and financially and to develop the necessary cost and management statistics that will permit us to do the job most efficiently. Until that additional mission is recognized adequately, its effectiveness cannot be appropriately evaluated and accounting systems will remain something to be tolerated.

Education and Training

The specialization gap, or rather the communications gap between specialists is largely due to the existence of a broader underlying problem, that of education. In his book, Beyond Automation, John Diebold states that "the great issues of the world can often be narrowed to a single point. This is certainly true in the case with automation. The machines and

the problems they pose for management are enormously complex, but one problem emerges as basic. That problem is education."[1]

Certainly, the financial managers of today have not escaped the problems nor the need. "Financial management is no longer a clear-cut, well-defined field. More and more it overlaps into many other jurisdictions and the financial manager must be better trained and more technically informed than ever before to handle his broadening field.[2]

An article by a CPA in the St. Louis office of Ernst and Ernst offers some interesting speculation as to why the field may be broader than the managers. He also gives some insight into the problem of the "green eye-shade" image accountants often project.

> Perhaps public accounting for many years has suffered from acute market myopia. Theodore Levitt described ten years ago how railroads failed to reach their potential because they assumed themselves to be in the railroad business rather than the transportation business. So public accounting has seen its role too narrowly in the business community. We have been product-oriented instead of client-oriented. We have overemphasized the financial statements to the point that they become an end in themselves--an attitude that top management must frequently find incomprehensible. Sometimes we show such a concern for absolute accuracy, an obsession with detail and a negative type of conservatism (none of them qualities of good executives) that it is difficult for clients to picture us in a constructive role. Thus the word 'auditor' conjures up in the minds of many chief executives the antithesis of the person he needs to help maintain or restore corporate health.[3]

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[1]John Diebold, Beyond Automation (New York: McGraw-Hill Book Co., 1964), p. 79.

[2]A. Keith Buckland, "Where Are We Going in Financial Management?", Financial Executive, XXXV (May, 1967), p. 24.

[3]Billy K. Check, CPA, "Education and Professional Training," The Journal of Accountancy (February, 1971), p. 85.

He also offers some advice for relieving the situation.

> First, we must correct our myopia and see ourselves as physicians to business. We must know more about how to use computers. We must be more math-oriented. We must know more about behavioral science. We must be leaders in the management sciences revolution.[1]

Judging from the comments of the Blue Ribbon Defense Panel study of the Defense Department, the auditing function is also suffering from a need for better education.

The American Institute of Certified Public Accountants team found that:

> . . . there are a number of factors . . . which are preventing the auditing function within the Department of Defense from reaching the level of efficiency and competence that we believe can be obtained.

They further found the following deficiencies in the organization of the Pentagon:

> There is substantial opportunity for improved and more efficient education and training of professional audit personnel through the use of joint facilities and programs.
>
> There are insufficient specialists, particularly those with experience in EDP auditing and statistical sampling, in the internal audit groups.
>
> 'We find,' the AICPA team said, 'that the various internal audit groups within the Department of Defense are not well equipped to deal with the challenge of electronic data processing. Training of audit personnel is not specifically directed toward audit techniques to be used in audits of computer installations. As a result, internal audit personnel as a whole lack sufficient orientation in the EDP area.
>
> This situation is further aggravated by a lack of specialized EDP technicians within the internal audit groups in the military departments and defense agencies. Systems common to each of the military departments, some of them would appear to have common processing requirements, are being developed independently and in some military departments without adequate regard

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[1] Ibid., p. 87.

for the implementation of proper audit trails and operating procedures.[1]

As one would expect, the Defense Department is increasing its educational program both formally and informally to keep pace with the new environment. Some advice from Paul Kircher is germane at this point.

He sees no easy way out, "Workers on both sides [of the communications gap] are going to have to take time to study the fields in which they are deficient. In many cases this means that they will do best to go right back to the beginning . . . for engineers to take principles of accounting and work up to a modest understanding of systems.[2]

The problem for the accountants is not so easy. Beginning engineering will not be much help. Just as with the use of the automobile or the telephone, we do not need to know much of the fundamental engineering in order to be able to operate the equipment.

At the moment it seems that every available avenue should be explored, for the amount of information to be obtained from each is not great. There is no single source suited to all of a corporation's needs. In fact there is reason to believe that ultimately many electronic installations will be made up of components produced by several manufacturers, each component chosen for its particular capabilities. The accountant (and

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[1]News Report "Institute Committee Proposes Defense Auditing Changes," The Journal of Accountancy (September, 1970), pp. 16-22.

[2]Paul Kircher, "The Gap Between the Electronic Engineer and the Accountant," p. 13.

the executive) will have to be prepared to evaluate each of these in the light of his own requirements, which no single manufacturer can evaluate for him from an unbiased point of view.

It is necessary to read the material that is published in magazines, attend conferences that are scheduled by universities and other groups, study the current releases of the electronic manufacturers, make friends with the experts, and so on. All in all, this is such a mixed bag that it is a full time job to cover it adequately, while initiating the studies that are needed for the firm's internal requirements.[1]

Audit of the System

The external parties with an interest in the financial transactions and stewardship of the Navy have a constitutional right to that information. The Constitution of the United States provides:

> No money shall be drawn from the Treasury, but in Consequence of Appropriations made by law, and a regular Statement and Account of Receipt and Expenditures of all public Money shall be publsihed from time to time.[2]

The recipients of the product of the Navy's financial accounting are not the arrayed forces of stockholders, executives, or even regulatory bodies such as the Securities and Exchange Commission.

> The audience, if that is a fair term, is composed of the collective elected proxies of the real equity holders,

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[1] Ibid.

[2] U.S., Constitution, Art. I, sec. 9.

> the public. The objective . . . is to reveal to the public its return on the investment of its tax investments as interpreted by its chosen securities brokers, the members of Congress. Compilation of the figures for this purpose is conducted along formal lines and adheres to 'generally accepted accounting principles,' but the principles involved would mystify and perhaps horrify the American Institute of Certified Public Accountants.[1]

No matter how desirable a system might be, it cannot be installed unless it meets the reporting and control requirements of Congress and of the auditors, including GAO. The increasing role of the computer has had considerable impact on the system's auditors, both GAO and the Navy's own internal auditors.

This impact on GAO was discussed by Earl M. Wysong, Jr., in an article in GAO Review.

> In view of the increasing utilization of electronic computers for processing data in the Government environment, it is important that we, as GAO auditors, are able to adapt ourselves to the new auditing concepts which have been created by the revolutionary methods used by these machines for processing data and producing reports . . . .
>
> The Federal Government in recent years has experienced a tremendous growth in its dependence upon electronic data processing equipment. Further increased computer utilization is anticipated in future years as evinced by the Presidential Memorandum on ADP, dated June 28, 1966, which states in part:
>
> > 'I want the head of every Federal agency to explore and apply all possible means to
> > -- use the electronic computer to do a better job
> > -- manage computer activity at the lowest possible cost.'
>
> This added emphasis on computer utilization coupled with the increased sophistication of computers and

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[1]U.S. Marine Corps Order P7300.8A, Financial Accounting Manual, Chapter II, p. 3, quoted by Peter A. Duffey in "Controllership and Marine Corps Comptrollership: A Dual Survey," p. 53.

> peripheral equipment has led to the development of new concepts of automating and integrating data processing systems. As a result, our audit approaches, examination techniques, and systems evaluation procedures must be realigned in accord with the concepts of electronic data processing systems.[1]

The driving force behind this need for new approaches, techniques and procedures appears to be the lack of a visible audit trail. This changing of the traditional audit trail must necessarily affect systems auditors and systems designers alike.

Some of the changes in the audit trail are cited by Gordon B. Davis:

1. Source documents, once transcribed into a machine-readable input medium, are no longer used in the processing cycle. They may be filed in a manner which makes subsequent access difficult.
2. In some systems, traditional source documents may be eliminated by the use of direct input devices.
3. Ledger summaries may be replaced by master files which do not show the amounts leading up to the summarized values.
4. The data processing cycle does not necessarily provide a transaction listing or journal. To provide such a listing may require a special action, using significant additional cost.
5. It is sometimes unnecessary to prepare frequent printed output of historical records. Files can be maintained on computer media and reports prepared only for exceptions.
6. Files maintained on a magnetic medium cannot be read except by use of the computer and a computer program.
7. The sequence of records and processing activities is difficult to observe because much of the data and many of the activities are contained within the computer system.

This changing audit trail is a growing challenge to the auditor. Records once easy to read are becoming visible only to the computer. Source documents are being

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[1]Earl M. Wysong, Jr., "How Can We Audit the Computer?", GAO Review (Spring 1967), pp. 53-54.

> eliminated. Printed listings are being replaced by totals; to do otherwise unnecessarily slows the equipment. As managements develop EDP systems to their fullest potentials, auditors will be less and less able to rely on traditional audit trails.[1]

Another consequence of the audit trail change is that it has increased the opportunity for enterprising individuals to falsify records in their favor.

> 'I could steal a company blind in three months and leave its books looking balanced' boasts a data processing specialist. His method would be electronic embezzlement using the company's own computer. A manager of a brokerage firm did use his company's computer to siphon off $250,000 during an eight-year period. He programmed the computer to transfer money from a company account to two customers' accounts--his own and his wife's. The computer was further programmed to show that the money had been used to purchase stock for the two accounts. He then sold the stock and pocketed the cash.[2]

> An enterprising employee at another firm instructed its computer to write checks to fictitious persons over a four-year period and send them to his home address. His scheme was uncovered only when the post office accidentally returned one of the checks to the firm and the clerk who received it became suspicious![3]

These examples dramatize the need for adequate internal controls (which must be designed into the system) and continual monitoring of EDP systems.

The American Institute of Certified Public Accountants (AICPA) defines internal control as follows:

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[1]Gordon B. Davis, Auditing and EDP (New York: American Institute of Certified Public Accountants, 1968), quoted by Richard C. John, and Thomas J. Nissen in "Evaluating Internal Control in EDP Audits," The Journal of Accountancy (February, 1970), p. 34.

[2]Alan Adelson, "Crooked Operators Use Computers to Embezzle Money from Companies," The Wall Street Journal, April 5, 1968, p. 1, quoted Ibid., p. 31.

[3]Richard C. John and Thomas J. Nissen, "Evaluating Internal Control in EDP Audits," The Journal of Accountancy (February, 1970), p. 31.

> Internal control comprises the plan of organization and all of the co-ordinate methods and measures adopted within a business to safeguard its assets, check the accuracy and reliability of its accounting data, promote operational efficiency, and encourage adherence to prescribed managerial policies. This definition . . . recognizes that a 'system' of internal control extends beyond those matters which relate directly to the functions of the accounting and financial departments.[1]

The AICPA committee on auditing procedures states the importance of internal control in their second standard of field work:[2]

> There is to be a proper study and evaluation of the existing internal control as a basis for reliance thereon and for the determination of the resultant extent of the tests to which auditing procedures are to be restricted.[3]

> Weaknesses in internal control provide opportunities for defalcations to go undetected. Although an audit usually is not designed to detect fraud, every auditor is charged with reviewing internal control. To evaluate internal control in the EDP area, the auditor must have some skilled understanding of EDP. . . . Since this standard demands that all internal control be evaluated, review of internal control must include a review of internal control in the EDP function.[4]

A report by the accounting firm of Lybrand, Ross Brothers, and Montgomery, maintains that:

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[1]Auditing Standards and Procedures, Statement on Auditing Procedure No. 33, committee on auditing procedure of the American Institute of Certified Public Accountants, New York, 1963, p. 27.

[2]John and Nissen, "Evaluating Internal Control in EDP Audits," p. 31.

[3]Auditing Standards and Procedures, Statement on Auditing Procedure No. 33, committee on auditing procedure of the American Institute of Certified Public Accountants, New York, 1963, p. 27.

[4]John and Nissen, "Evaluating Internal Control in EDP Audits," pp. 31-32.

A distinction between features of internal control which promote the reliability of financial data (internal accounting control) and those features principally concerned with safeguarding assets (internal check) is important in the consideration of the separation of duties in EDP operations. In the past, the need for good internal check has required the separation of duties, so that the authorization for a transaction, the recording of the transaction, the processing of the transaction, and the custody of the asset have been separated. With EDP systems, the implementation of the separation principle becomes difficult.

For example, there is a tendency to have loose organizational relationships between:

systems analysts and programmers,

computer operators,

key punch personnel,

the control group, and

the program and file tape library.

Responsibilities are often not well defined, and one person can be performing duties in several of these functions. Such a situation improves opportunities for introducing fraudulent data into the system or manipulating the programs. The systems analysts and programmers are also in a position to redesign the system and change the internal controls.

As a practical matter, an auditor's attempt to introduce more separation of duties in a smoothly running EDP operation will usually encounter antagonism. The people enjoy their ability to perform several functions, and they feel that efficiency will suffer if they are restricted. And to date, very little fraud has been detected in EDP operations. This is no reason to relax vigilance, however, since fraud will probably increase as experience with EDP grows, so that the importance of a careful use of available control measures will increase also.[1]

Although the possibility of fraud must always be considered and appropriate internal checks designed into the system, there is another area of problems which permeates the system. This area has been termed the "Error Environment"[2]

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[1]Lybrand, Ross Brothers and Montgomery, "The Control and Audit of Electronic Data Processing Systems," (U.S.A. Lybrand, Ross Bros. and Montgomery, August, 1965), pp. 23-24.

[2]Ibid., p. 6.

and has created significant changes in the internal control system.

> The installation of an EDP system introduces the possibility of new types of errors in processing of data. Much of the data to be fed into the computer must first be manually punched into cards or paper tape, and this key punching operation can introduce error. Each step or process that translates data into a new form increases the potential for error. The computer operator can use the wrong magnetic tape for a computer operation, can use an obsolete version of the program (the procedures which the computers follow in processing the data), can process the same data twice, or skip a batch of data. An error may also be made in a computer program itself.
>
> EDP also brings 'quiet' errors to light--errors that were either quietly corrected or unobserved in the previous system. In transferring manual records to a computer, many errors of long standing are usually found. Manual systems are flexible, with personnel regularly interpreting, adjusting and acting upon less than perfect documents. When exposed to the rigid discipline of computer programs, some of these documents will be unacceptable.
>
> The EDP error-correction process is necessarily more complex because it is necessarily more formal, and error detection tends to be more concentrated than in manual systems. Because error-detection is emphasized in the first run of data, all inconsistencies in a day's batched transactions must be resolved on a strict schedule in order for records to reflect actual current conditions. . . .
>
> Offsetting these developments which tend to increase errors have been the very high reliability of the computer itself and the ability to develop special manual and programmed measures to reduce the incidence of errors and to increase the efficiency of detecting those which do occur. Data which have been entered into the computer will be processed according to the program with a very high degree of assurance, and both manual and programmed control measures can enhance that assurance.
>
> In the face of the new factors in the error environment that accompany EDP, controls are necessary at each stage of the data processing. The auditor must determine, in the course of his audit, whether thses controls exist, whether they are adequate in the specific situation, whether they are being followed, and how they can be checked.[1]

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[1]John and Nissen, p. 32.

So far we have seen ample evidence of the need for good auditing techniques and the need for designing control factors into the system that would facilitate auditing. Let us turn now to a necessarily abbreviated look at the nature of an EDP system audit.

> Whether the audit is of a computer system or of a manual system, internal control is evaluated in terms of the same criteria--i.e., the controls must provide reasonable assurance that information is correctly processed and complete. To assure himself concerning the EDP function, the auditor should evaluate three major areas of internal control: (1) organizational, (2) administrative and (3) procedural.
>
> Organizational Controls. Organization has always been important in the structure of internal controls. Because of the greater concentration of data processing duties in the EDP system, organization becomes even more important. . . . Organizational controls falls into two areas: the placement of the EDP function within the organization and the division of duties within the EDP group.
>
> Within the organization, the EDP group should be functionally independent in its relationship to other operating departments. . . . Where possible, data processing should be a separate functional area. Such an organizational setup enhances control by preventing domination of the equipment by one user such as accounting or manufacturing. . . . Proper division of duties within the EDP department means dividing duties among the available personnel to minimize opportunities for manipulation. These controls are part of a sound organizational structure in which administrative and procedural controls can function effectively.[1]

Literature on auditing EDP systems has included several proposals:

> explicit formal separation of duties between systems analysts and programmers, computer operators, keypunch operators, etc.,
>
> rotation of computer operator assignments,
>
> the use of fidelity bonds for data processing personnel in positions of trust, and
>
> restriction of the access of computer operators to program details.

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[1] John and Nissen, p. 32.

> Although desirable, and recommended by most of the literature, formal separation of duties is not widely nor consistently practiced at present, few companies rotate computer-operator work assignments, and limited use has been made of fidelity bonds.
>
> The computer operator should be given only those instructions necessary to set up and run the program and to handle all contingencies provided for in the program (such as a machine stop when an error has been detected). Since the computer operator is in a key spot for manipulating a program and can do so with no effect on the authorized program stored on the program library tape, carefully enforced restrictions upon his access to program details can restrict the opportunities for fraud.[1]

The second major area of internal control which the auditors should evaluate is administrative controls. The areas of major interest are program documentation and program testing.

> EDP documentation is more complete and up to date (even when inadequate) than is true of most manual systems documentation. Because of the characteristics of the computer, programs must account for all eventualities. Since the computer will follow the prescribed program rigorously, the documentation is a prime source of knowing how the system will perform.
>
> The following documentation should be available in an EDP installation. . . .
>
> 1. overall system flow charts;
> 2. narrative;
> 3. machine process (run) charts;
> 4. program (block diagram) logic charts in several progressively more detailed stages;
> 5. coding sheets;
> 6. assembly or compiler printouts;
> 7. program change sheets;
> 8. transaction and master record layouts;
> 9. sample forms and documents, and
> 10. operator instructions.

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[1]Lybrand, Ross Brothers and Montgomery, p. 26.

> In practice these documents are often not available, and when they are, they may not all be up to date. For example, items 1 through 5 are used initially as tools to arrive at the program, and as the program gets into the 'debugging' stage (at which time program errors are detected and eliminated), they are in many cases not kept up to date and soon become almost obsolete. Good practice, however, is to keep this documentation current, and because deficiency in this area is detrimental to control, the auditor should make a careful review to see that current information is maintained. . . . Some of the documentation can also be used to trace the system's internal accounting control features. Of greatest value for this purpose are the system flow charts, machine process charts, error code listings--with associated operator instructions--and record layouts. With these the auditor can see just what fields the data are carried in the system, what the flow of data is through the system, and the types of errors the computer has been programmed to detect. None of these require the auditor to get into the intricacies of a computer program.[1]

> Proper documentation primarily serves the purposes of management, but from an audit standpoint, it is an invaluable part of the review of internal control. Details of record formats, layouts, code structures, system flowcharts, etc., assist the auditor in developing meaningful tests of the system--especially if he intends to audit through the computer.[2]

Before beginning a discussion of program testing, the second aspect of administrative control, we must consider the merits of auditing "through" the computer and those of auditing around the computer. This consideration has been the subject of much discussion and numerous articles.

> Auditing 'around' the computer means that a representative sample of transactions is manually traced either from source to final reports or from the final reports back to source documents. This tracing is done by using the computer printouts as if they were manually maintained records. The thesis is that if the sample of transactions has been handled correctly, then the system outputs can be considered to be correct

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[1] Ibid., p. 28.

[2] John and Nissen, p. 32.

> within a satisfactory degree of confidence. The main advantage of the 'around' approach is that the auditor is on familiar ground--he is not required to have a technical knowledge of the computer to the degree necessary when the 'through' approach is used. The approach independently tests the results produced by a system which relies upon a fallible machine controlled by fallible people.[1]

A further advantage pointed out by John and Nissen is that the "around approach has the advantage of minimizing the interference with the day-to-day processing operations and presents no risk of tampering with 'live data.' The around-the-computer approach works well if the system is on a batch process basis, if transactions are initially recorded manually and if the audit trail is characterized by extensive printouts."[2]

There are, however, ever increasing difficulties with the "around-the-computer" approach. As the traditional audit trail disappears there is a concurrent changing of the form of data.

Auditable and non-auditable data are combined in the files. Multiple use is made of single transactions. Source documents are often stored at remote points.

Even when the approach can utilize enough data to make the audit possible there are still two sizeable major objectives.

> First, this approach may not be able to provide managements with the same degree of assurance that the internal controls in the EDP system are in fact working as does the 'through' approach. With the reduced number and wide dispersion of source documents, the reduced amount of information printed out for examinations, and the machine and programming nature of controls, assurance about internal controls is increasingly difficult to obtain by traditional means.3

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[1]Lybrand, Ross Brothers, and Montgomery, pp. 4-5.

[2]John and Nissen, p. 35.

[3]Lybrand, Ross Brothers, and Montgomery, p. 5.

> Finally, the auditor cannot ignore the computer. He must make a thorough evaluation of the organizational, administrative and procedural controls in the EDP department even though he tests around the computer. Thus, evaluation requires a knowledge of EDP on the part of the auditor, if he is to comply with the second standard of field work.[1]

The degree of EDP knowledge required for this approach would, of course, vary with the size and complexity of the system being audited. Certainly, this approach would require some EDP knowledge, but not the technical knowledge required by the alternative "through the computer" approach. We now turn to consider the alternative.

> The notion of auditing through the computer was first suggested in 1955 by Samuel J. Broad,[2] and it has been discussed and amplified by many other writers since then. It is diametrically opposed to the older approach of auditing around the computer or leapfrogging the computer as it has sometimes been called. Auditing through the computer embraces a spectrum of possible auditing techniques, any one of which might be applicable in a given situation.[3]

"In auditing through the computer, the computer is used to obtain information about the operation of the programs and about controls built into the machine itself."[4]

> The advantage of the 'through' approach are that it can provide direct assurances as to the functioning of the system and that it affords the opportunity to use more precise audit techniques. The computer can be used to select items for detailed analysis, and to perform some or all of this analysis. Auditing through the computer is particularly advantageous

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[1] John and Nissen, p. 35.

[2] Samuel J. Broad, "The Progress of Auditing," The Journal of Accountancy (November, 1955), p. 42, quoted by Wayne S. Boutell, "Auditing Through the Computer," The Journal of Accountancy (November, 1965), p. 41.

[3] Boutell, p. 41.

[4] John and Nissen, p. 35.

> for auditing on-line-real-time and/or fully integrated systems.
>
> The main disadvantage of the 'through' approach is that the auditor must first prepare himself with intensive training in the concepts of EDP systems and machines, and then must deal with a considerable amount of technical detail during the individual audits.[1]

"There are three audit approaches: using test decks, using 'packaged' programs, or using unique programs for each client."[2]

A test deck has been described as "a set of dummy transactions created to simulate actual events in order to test the procedures and controls in a computer program."[3] Although the term "test deck" implies the use of punched cards, any appropriate machine readable medium may be used.

The development of test decks requires a clear understanding of the data processing system and the system of controls used in it. The auditor should be primarily concerned with the system of controls. "The error input should relate directly to the specific system controls which are critical to his objective of being assured that he can rely on the system as an information source. He will probably want to attempt to violate all the designed quality checks in the edit program."[4] However he should also "test the systems handling of transactions with

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[1]Lybrand, Ross Brothers and Montgomery, p. 6.

[2]John and Nissen, p. 35.

[3]Lybrand, Ross Brothers and Montgomery, p. 30.

[4]John and Nissen, p. 35.

vital fields of information missing or transposed, transactions with erroneous code numbers, duplicate transactions, etc., irrespective of whether the program provides for these contingencies."[1]

John and Nissen suggest six elements which should be covered by the test deck. They are:

1. Out-of-balance batches of input
2. Normal transactions
3. Invalid data such as (a) alpha data where numeric should be, (b) invalid dates or account numbers, (c) incomplete data or (d) data larger than the field size
4. Edit routine violations
5. Out-of-sequence processing
6. Processing with the wrong file.[2]

"Since the objective is (often) to test the system rather than some specific output data, it is usually satisfactory to apply test deck transactions to dummy records . . . . This will usually mean the use of an ancestor tape, i.e., a grandfather tape obsoleted by the production of new 'son' tapes."[3]

There are circumstances that dictate the use of "live" data. For example, it may be desirable to test how the control group responds to and handles errors. Internal audit may require the "continuous audit" procedure of injecting dummy transactions into the system at various times and places.[4]

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[1]Lybrand, Ross Brothers and Montgomery, p. 32.

[2]John and Nissen, p. 35.

[3]Lybrand, Ross Brothers and Montgomery, pp. 32-33.

[4]Ibid., pp. 33-34.

These methods don't require special computer runs for the audit and are therefore less expensive, however the auditor must identify his test data so that they may later be "backed out" so as not to distort or destroy real data.[1]

In older systems where the number and complexity of program changes are great, the test deck approach is especially useful as a parallel check on the documentation.

> A big advantage of the test-deck approach is that program changes are of little concern to the auditor, if the revised programs continue to produce acceptable output from the test data. Once a test deck is developed, it can be run and evaluated frequently. On the other hand, a test deck is costly to develop and can be used on only one client's system.
>
> The successful run of test data through an existing program assures the auditor that the tested controls exist in the program. That is all it will do. The question of whether the tested program was in use during the entire period is a separate question, one not unique to EDP systems. This question is answered through analysis of organization, administrative and procedural controls.[2]

The second and third audit approaches, namely packaged or unique programs, have apparently not been as successful as has the test deck approach. In 1965, Wayne S. Boutell considered it a "model approach to the problem," implying a double meaning to the word "model." His thesis was that the auditor does have a model in mind when he makes his review and this model is necessary to evaluate the system of internal control. The idea was to make his mental program explicit, program it and run a sample of the source data through both the clients program

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[1] John and Nissen, p. 36.

[2] Ibid.

and the "model." A comparison of the results would then reveal any significant differences.[1] Obviously, this approach requires a great deal of computer expertise.

A more recent observation is that: "To date, [1970] the use of packaged computer audit programs has been very limited . . . . As a practical matter today, differences in equipment and software sometimes make extensive use of packaged audit programs impractical . . . . Using computer programs in conducting his audit requires the auditor to have a higher level EDP knowledge than either auditing around the computer or the test-deck approach through the computer. This is probably why auditors seldom use them."[2]

Lybrand, Ross Brothers, and Montgomery list the following "prerequisites to the use of specially written computer programs:

1. The auditor must be able to define his audit objectives and requirements.
2. he must be able to program his requirements or have access to a programmer who will reliably fill them, and
3. the required time and effort should be justified by the results achieved."[3]

The third and major area of internal control which the auditor should evaluate is procedural controls. This area includes the life cycle of data from the initiation of data to the final disposal of the output generated, including the operational controls involved.

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[1]Boutell, pp. 41-47.

[2]John and Nissen, pp. 36-37.

[3]Lybrand, Ross Brothers and Montgomery, p. 35.

Initiation Controls. The authority, propriety and accuracy of transactions to be processed must be insured. Fortunately, the data is often in humanly recognizable form at this stage so traditional controls such as transaction counts and visual checks will apply to many of the transactions. However, "EDP has introduced a new factor in that the computer can initiate important transactions, such as purchase orders and production orders. Where this has occurred, management must clearly understand just how much authority has been granted to the computer program, and checks are needed to make certain that the bounds of this authority are not exceeded."[1] Test decks which violate the bounds of this authority are useful in checking these controls.

Conversion and Input. Some writers separate these two steps, however, there is good reason to treat them as a single step. There is often no clean break between the point where data is converted from human language to machine language. Indeed, in the recent development of Optical Character Recognition, there is no "conversion" step at all. The data is at once readable by both humans and machines. Too, the controls needed to insure accurate conversion are in most cases the identical controls needed to insure accurate and complete input to the computer. For these reasons, conversions and input will be considered as a single step for discussion of the control process.

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[1] Ibid., p. 8.

Conversion and input are considered by most writers as one of the most crucial to a successful operation. John and Nissen consider it to be

> . . . the weakest link in the chain of processing events. Controls can be designed into computer programs to check for various errors. Routines can be established between and within the various departments to detect errors. However, if at the point of origin of the transaction an error is made in recording the data, it may easily pass undetected through the system. In EDP systems, the conventional control techniques to reduce the possibility of error in the initial recording of the data are extremely important.[1]

When the data conversion from human to machine language is largely mechanical as with machine recognizable characters, there is less chance for human error or manipulation and less stringent controls needed.

> The greatest need for control occurs when this conversion is accomplished by manually keypunching data into punched cards or punched paper tape. Several techniques are used to control the accuracy and completeness of the conversion operations.[2]

The techniques fall generally into three categories; (1) human re-check, (2) programmed checks which the computer performs and generally reports to the user, and (3) built-in equipment controls which report programmer errors and equipment malfunction to the computer operator.

The human re-check category would include for example, the following checks:

> Mechanical keystroke verification. This is the most expensive form of conversion verification, and is generally used for fields of data in which error can be least

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[1]John and Nissen, p. 33.

[2]Lybrand, Ross Brothers and Montgomery, p. 11.

tolerated. After cards or paper tape have been key-punched, a second operation authenticates the cards by restroking all fields of data subject to process on equipment which signals discrepancies.

Visual verification. Usually used for alphabetic information, this method consists of sight comparison between the original document and what has been keypunched, or of holding a deck of punched cards to a light source to see that an identical field has been correctly punched in all cards. . . . Visual verification is not as accurate as mechanical keystroke verification and is accordingly used for those fields of information where some checking is desired but less accuracy can be tolerated.

Self-checking numbers. For checking of identification-type numbers, self-checking-numbers techniques are highly effective. They apply to code numbers such as employee numbers, account numbers, etc.

Because considerable literature is available on various types of self-checking schemes, no detailed description will be given here. Briefly, one extra digit, computed from a mathematical relationship of all the digits in the code number itself, is added on to the end of the code number which it is to check. The new code number then becomes the old code number plus the check digit. . . . It is important to note that although self-checking numbers are usually effective, they are not infallible, because erroneous numbers can sometimes combine in a way that will pass the test. (The probability is remote, but must nonetheless be recognized.)[1]

The second technique for controlling conversion and input of data is to program certain edit or validation checks into the computer.

Because of the speed and consistency of the computer, well-designed programed edits can perform a continuous internal audit of all data entering the computer. Edit checks are used to detect data which are inaccurate, unreasonable or incomplete. They include checks for reasonableness of data, e.g., a check to assure that a disbursement does not exceed some specified limit. Common edit routines include: limit checks, validity checks, sign checks, field checks, historical comparisons and logical relationships.[2]

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[1] Ibid., p. 12-13.

[2] John and Nissen, p. 33.

Additional routines might include such things as character made tests to see that all characters within each and every field are what they should be (i.e., alphabetical or numeric). Finally, an authorization test can be made to determine whether the department specified in a transaction is authorized to initiate that kind of transaction.[1]

The third technique of data control, that of built-in equipment controls, controls not only the input of data, but its subsequent movement through the processing. Although there is not much the auditor can do about these controls, he should know of them.

> The most prevalent form of built-in control is the parity check, for checking the accuracy of data transfers within the computer system. Each character of data is represented by a series of binary digits (four, six, or eight binary digits per decimal digit or character). A parity digit is one extra binary digit per character. If, in the course of transfer, one binary digit is changed within a character (which is the error most likely to occur), the parity digit will no longer check out and thus detect the error. This technique is used in checking the transfer of data within the computer and also between the computer and external storage units, such as magnetic tape units or random access memories.
>
> Another check often made with magnetic tape units and random access memories is the read-after-write check. After information has been recorded, the computer reads it right back, and it is checked by a variety of schemes that test its accuracy. A discrepancy automatically signals an error.
>
> Punched card and punched tape units have a dual-read feature, by which cards or tape are read twice as they are being fed into the machine. A read-after-punch feature is also available on some punching equipment.[2]

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[1] Lybrand, Ross Brothers and Montgomery, pp. 13-14.

[2] Ibid., pp. 14-15.

Once data has been recorded by an initiating department, they will be transferred through other departments for processing. Regulation of the movement of data "usually takes two forms:

1. batch controls, and
2. a 'control group' of personnel directing the flow of data to and from the computer."[1]

Discussion of the latter form will be deferred until the techniques of operational control are considered.

Batch Control. A batch is a "quantity of transactions which have been saved up to be handled as one lot."[2] A batch may include all the transactions for some period of time or it may be a fixed number of items.[3] The types of transactions included in a batch should be as homogeneous as possible, to provide inherently consistent control totals.

In using the technique, a total of the critical data in the batch is obtained prior to its submission to the next receiving department. The originator and the receiver each keep a log of the totals.[4]

> Within a batch, several types of controls are used. Commonly used is the item count, which is a count of the number of items or transactions in the batch. (This count is not always a simple one; for example, transaction types that might involve a variable number of documents per transaciton make it difficult to know just what to count, the transactions or the documents).
>
> An equally common batch control is the control total. This is a total of one information field, for all items

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[1] Ibid., p. 8.

[2] Ibid., p. 46.

[3] John and Nissen, p. 33.

[4] Ibid.

in the batch. An example for a batch of sales orders would be the dollar total represented by all of the sales orders.

A less frequently encountered but useful batch control is the hash total. Like the control total, this is a batch total for all items of one field of information. Here, however, the total itself has no intrinsic meaning--for example, totals of employee numbers, account numbers, part numbers, etc. Once control or hash totals have been manually developed, it is desirable to have the computer accumulate matching batch totals in each run in which the corresponding transactions are being processed and to compare the computer developed totals with the predetermined totals.[1]

This control procedure is, of course, equally as useful in controlling data from one computer run to another as it is in controlling data from one department to another.

After the computer program has been run, it is necessary to make a final check on the output to insure no records have been lost (or added) by the computer or by an enterprising operator. Output control methodology might operate as follows:

Control totals of processed information are compared to input control totals. These can be batch totals of the number of records processed or totals of some other significant figures in the batch. This comparison of totals is the fundamental control feature in a batch processing system.

The use of prenumbered forms is helpful in maintaining output control. Prenumbered output documents can be accounted for in the same manner as input documents. The number of payroll check forms, for example, can easily be checked against the number of input records. Through the use of sampling, auditors can check output by tracing randomly selected transactions from source documents through the processing system to the output destination.[2]

Operational Controls. The physical layout and organizational arrangement of the data processing department is of

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[1]Lybrand, Ross Brothers and Montgomery, p. 10.

[2]John and Nissen, p. 34.

vital concern to the auditor. Manipulation of records requires a working knowledge of the programs, sufficient time at the console, and motivation.

> Good internal control reduces the possibility of unauthorized manipulation of data. Access to the computer must be limited. An organization with good controls limits access to the computer room to only those employees concerned with operation of the equipment. Another area of strict control is programs. Once written, object programs should be accessible only to equipment operators; source programs should not be accessible to them. This control makes very difficult the unauthorized modification of programs by the equipment operator.
>
> Important elements of this kind of control, for which the auditor should be looking, include:
>
> 1. Organizational division of functions.
> 2. Effective scheduling techniques and standards for operations such as halt logs and controlled console printouts.
> 3. Written instructions covering each job.
> 4. A log of computer running time with appropriate control.
> 5. Control over movement of data--especially of rejection and return of bad batches of data.[1]

A suggested method for effecting the final element is the establishment of control groups, i.e.,

> have a single control group of clerks into which all data flowing to the computer is channeled, and from which all computer reports are distributed. Such a group provides a single communications point with the computer room and adapts itself better to the strict scheduling requirements of EDP than do individual departmental control groups.
>
> The control group develops the necessary batch control figures, or, where they have been previously developed, records the figures and checks to see that all batches have been received. The group checks the input control totals developed by the computer against previously developed control totals. Any discrepancies

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[1] Ibid., p. 33.

> are tracked down and correction entries made. (If so programmed, the computer itself can perform the comparison operation and print out only those batches that fail to check.) The control group checks output-control-totals before output documents are released for distribution. An example in a cycle billing operation is to check that the bills actually produced for a cycle agree with the final control totals for that cycle, just prior to billing.
>
> If one type of errors appears too frequently, the control group should be instructed to call this to the attention of data processing management so that the cause of the error can be determined and corrective action attempted.[1]

A final word of caution to the auditor or designer of EDP accounting systems, is that equipment is not infallible. There are a great number of errors which can occur in the processing of data. These errors occur most often in the computer-human interface or within "peripheral units" which are largely mechanical and thus more error prone than the computer itself.

> This can be illustrated by the kinds of misoperations which can occur in magnetic tape units and the effects they can have. Tape units may:
>
> start below normal speed,
>
> stop and/or back-space improperly, and
>
> signal improperly at terminals such as load points or end of reel.
>
> Although such misoperations are infrequent, and may be slight by mechanical standards, they do occur and can produce unfortunate consequences.[2]

People Problems

Colonel Joseph B. Warren has leveled a challenge to the managers of data automation. His challenge is, as the

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[1] Lybrand, Ross Brothers and Montgomery, p. 11.

[2] Ibid., p. 9.

title of his article says, that we have made EDP a scapegoat for human errors.

> During the first decade of our experience with the management of computers we emphasized the management of hardware--its design, acquisition, operation, and maintenance--rather than the management of the people who carry out these functions. We seem to have placed technical experts in a privileged position where computer hardware is blamed for failures or errors rather than the people who wrote and implemented error-ridden, failure-prone data systems. This seems to be true for large as well as small computer-based data systems.
>
> In the majority of cases, however, failure can be traced to human failures--failure to design well, failure to implement carefully, and failure to assure reliable computer operation. However, we are more inclined to tear out the computer than we are to fire the programmer . . . .
>
> We have fallen into the habit of using automated systems as the scapegoat for human error and failure. A logistic manager of a key operation in the Pacific complained that vast quantities of equipment and material were building up at his control point and he was losing the capability to control the inventory. His problem--as he described it--was that the computer available wasn't capable of processing data fast enough and the solution was simply to get a larger computer.
>
> The Commander of a supply center recently converted his system from a second generation computer to a third generation computer. The entire system had been redesigned, programs rewritten and extensive testing conducted over a three-year period. As soon as the new system was put into operation it began to flounder and his mission performance was jeopardized. Again the blame and responsibility were not attributed to human failure but to the size and capability of the hardware. The proposed solution was the same--a bigger and faster machine . . . .
>
> I would like to offer the following speculation: As computer applications come to have a more direct impact on the activities of every organization, management attention must be focused on the people involved in computer systems--as designers, programmers, users and recipients of computer-provided services--or there will arise a misplaced reaction against the continued application of computers to the solution of problems.[1]

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[1]Joseph B. Warren, "EDP, Scapegoat for Human Error," Business Automation, p. 50.

It is not the purpose of this paper to deny the charge nor to reiterate it. It is assumed that there are as many different types of "scapegoatism" as there are managers. Our purpose here is to respond to the challenge by investigating some of the problems and the underlying human factors which contribute to them.

The University of Wisconsin has done research in this area as early as 1965.[1] More current literature in the field tends to support their findings. Growing mechanization of data processing operations "has intensified the human relations problems inherent in the design of business systems. As a result, business managers and systems analysts are devoting increased attention to the impact of the financial information system on the people within their organization--and to that of the people on the financial information system."[2]

The design of a system should be consistent with applicable human factors since people are responsible for the effectiveness of the system. Dr. Bower and Mr. Sefert divide management into two levels for convenience in examining the human factors.

"Top management consists of those executives who participate in company wide policy formulation, including the chief executive and those who report directly to him."[3]

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[1]James B. Bower and J. Bruce Sefert, "Human Factors in Systems Design," Management Services, II, No. 6 (Nov.-Dec., 1965) Copyrighted 1965 by the AICPA, Inc., pp. 39-50.

[2]Ibid., p. 39.

[3]Ibid., p. 40.

In the Navy, this would correspond roughly to the Systems Command Headquarters and upward through the Secretary of the Navy.

"The term middle management is used to encompass not only the usual group of middle and junior executives, such as division managers, department heads, and their staff functional advisors, but also operating supervisors and foremen since the human factors that affect this group as a whole are similar."[1] The Navy counterparts to this category would include all of the field activities, offices and Inventory Control Points. The people in this category range from the Commanding Officer to the mail room supervisor.

"Non-supervisory employees are treated separately since their reactions to systems changes are usually different from those of people on the managerial levels."[2] A point often ignored, or at least naively avoided is that "a group of non-supervisory workers can sabotage a system they do not accept just as effectively as a supervisor can. In fact their sabotage may be even more difficult to combat since it may be more subtly applied through group action."[3]

What are the human factors that affect these workers? Bower and Sefert have developed a list of 23 such factors:

1. Resistance to the new and strange
2. Fear of machines
3. Tendency to believe rumor vs. fact

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[1] Ibid.

[2] Ibid.

[3] Ibid.

4. Need for reassurance as to job security
5. Trust in management
6. Pride in company progress
7. Need for group motivation
8. Desire for affection, recognition, attention
9. Tendency to short-range goals
10. Desire to know reasons for change
11. Need to identify with problems
12. Tendency to question company motives
13. Response to opportunity to participate
14. Need for activity and visible product
15. Passive resistance of affected groups
16. Fear of loss of respect for speciality
17. Resistance to inflexibility of machines
18. Influence of key workers
19. Dislike for more rigid work pace
20. Tendency to accentuate shortcomings of system
21. Instinct for self-protection from blame
22. Need for well defined goals and objectives
23. Faith in company promises.[1]

Several of the factors may be seen in the comments of one Navy manager who identified one of his problems as a lack of appreciation by lower level personnel for system discipline in coding documents and resulting mismatches. The mismatched documents often being corrected by a third party without access to the original document. This lack of "eyeball" corrections produces a need for elaborate edit routines. Further observations were that support personnel are manually oriented, not system oriented. Morale is depressed because of the depersonalized nature of things, e.g., where a clerk formerly handled accounts on a personal basis and developed familiarity with customers, now the impersonal machine handles the accounts.[2]

> The systems analyst cannot completely prevent the operation of these basic human factors. It will take a long time to substitute new values and new job

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[1] Ibid., p. 47.

[2] Pat Herrin, interview.

> satisfactions. If, however, he is aware of these forces at work, he may be able to offset them or at least minimize their effects by proper training and by introducing contrary forces.[1]

The key to success or failure of any system is held by the middle managers. "Top management relies on them for the organizations everyday efficiency and smooth operation; the non-supervisory employees take their direction and set their course for them."[2]

An understanding of the human factors at work in this group of managers and supervisors is especially important to the systems analyst since he must depend to a great extent upon the information the supervisors can furnish and also upon their later acceptance and implementation of any system he designs and installs.[3]

Bower and Sefert mention a number of special problems which middle managers generally present. They typically ". . . have a narrow perspective on company operations. They are so immersed in their own jobs and their own departments that they cannot see the significance of what is going on elsewhere in the company."[4] They also tend to pay more attention to the technical factors of their work and less to the human relations and administrative aspects. They are fearful of

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[1]Bower and Sefert, p. 49.

[2]Ibid., p. 44.

[3]James B. Bower, Robert E, Schlosser and Charles J. Zlatkovich, Financial Information Systems, p. 314.

[4]Bower and Sefert, p. 45.

automation that may reduce the number of employees and thus also reduce the number of supervisors. As their age increases, they tend to increase their resistance to change. They need evidence that a change will bring them immediate benefits, however not to the extent that lower level employees do.[1]

These factors are pervasive and require considerable effort by systems designers to overcome. Even systems that were designed specifically to help middle management have found rough sledding because of these deep seated factors. A nearly perfect example of this is Project PRIME. Very reasonable and surely desirable goals are stated for PRIME.

> Basically, Project PRIME seeks to revise the programming system, the budgeting system, and the management accounting system so that they will be more useful to managers at all levels. The sole purpose of Project PRIME changes is to aid managers--there is no desire to account for the sake of accounting or accountants. In this context, a manager is a person who is responsible for carrying out a significant mission or function and who in doing so makes decisions that have a significant effect on the resources used. Project PRIME is designed to aid managers in three phases of the management process: Programming, budgeting, and operations.[2]

Certainly one would expect managers to support such a noble goal. There is, however, evidence that such is not yet the case even though over five years have passed. Haskins and Sells found that:

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[1] Ibid.

[2] OASD (Comptroller), Defense Resource Management Systems: Project PRIME, National Security Management (Washington, D.C.: Industrial College of the Armed Forces, 1967), p. 9.

> Substantial problems have been experienced in Navy-wide installation of recently developed accounting procedures
>
> -- one example of this is Priority Management Efforts (Project PRIME) which some commands have adopted and find to be of value, but which others continue to resist or to reject
>
> -- another example is the attempted adoption of the accrual basis of accounting.[1]

It is beyond the scope of this paper to identify all of the reasons why some commands resist PRIME. It is reasonable to conclude, however, that much of the resistance is due to a failure to properly deal with the human factors which affect the middle managers. There must be active, conscious effort directed at overcoming the negative effects of these factors.

> . . . the employee in a company undergoing systems change is likely to develop a core of passive resistance to these changes if left to his own inclination and to the influence of his co-workers. This may be so in spite of the fact that if he were confronted with a specific proposal he might in a moment of objectivity admit that the changes were good and probably needed.[2]
>
> Top Management. It is axiomatic that the whole-hearted support of top management is required for systems acceptance and success. Middle management and non-supervisory employees are quick to take their cue from the attitudes that flow downward . . . .
>
> Mere interest and support . . . is not the whole answer, however. The analyst must take account of many human factors at this level in determining management information needs . . . .[3]

Bower and Sefert have identified a number of these top management human factors. Some of them are:

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[1]Haskins and Sells report, p. 18.

[2]Bower, Schlosser, and Zlatkovich, Financial Information Systems, p. 322.

[3]Bower and Sefert, p. 47.

Prior interest in procedures
Company patterns of change
Tendency to patchwork solutions
Concern for human relations
Strength of interest in change

Some clues to the nature of these factors as they apply in the Navy may be found from the observations made by Haskins and Sells:

> It was noted that while there are large numbers of persons involved in command comptrollership activities, there appears to be almost no direct centralized management of these activities beyond the general instructions contained in the Navy Comptrollers Manual.
>
> Evidence of lack of centralized management direction are manifested in a number of ways, most of which occur in some degree because of an inability to execute effectively. Some of the observed indications of lack of centralized direction are
>
> -- unclear definition of responsibility for direction of day-to-day accounting operations as necessary to achieve accounting-system objectives with a satisfactory degree of effectiveness
>
> -- parochial interests appear to be more intense than should be expected
>
> -- many overlapping systems efforts exist which propose to resolve the same or similar items
>
> -- lack of ability to summarize data for higher echelons in an effective and efficient manner
>
> -- proliferation of memorandum records to satisfy needs of managers through attempts to overcome deficiencies in official systems
>
> -- untimely preparation of accounting data
>
> -- insufficient definition of requirements for accounting operations
>
> -- insufficient definition of management requirements and the specifications of systems necessary to respond to those requirements
>
> -- attention focused on broad systems concepts with inadequate consideration of data source and data flow requirements.[1]

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[1]Haskins and Sells report, p. 16.

It is appropriate here to remind the reader that the critical examination which produced the above observation was done at the request of the Navy's top management. It was intended to identify and make explicit the problem areas. The writers purpose here is not to cast additional stones at management, but to illustrate the human factors involved in the design of a better system of accounting within the Navy.

A tendency to patchwork solutions is apparent in the following additional observation by Haskins and Sells:

> Many current practices appear to be the result of past system changes which, though probably well founded when installed, are no longer appropriate under today's operating environment. Further, many practices have perhaps resulted from expeditious modifications or additions undertaken over a period of time to fill urgent needs rather than from consideration of fundamental purposes.[1]

The above observations are not an attempt to completely and accurately illustrate top management position, but to show that human factors have influenced the design and operation of the accounting system. It is necessary that these human factors be recognized at all levels because, "as the plans for a major systems change unfold, top management will have to chart its course of action in the field of human relations."[2]

The computer has indeed brought many demanding problems with it. Rapid change is the new way of life and accounting has not escaped the trend.

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[1] Ibid., p. 22.

[2] Bower and Sefert, p. 43.

Many people are not prepared for the thinking that is required to live in this bold and demanding new existence. In effect, the computer has caused a revolution of thought that requires a reappraisal of many of the pillars supporting our business world.[1]

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[1]Buckland, Financial Executive, p. 24.

CHAPTER V

SUMMARY AND CONCLUSIONS

This research project has been concerned with the impact of the use of computers on the accounting systems in the supply system of the U.S. Navy. This impact can best be judged by breaking the problem into three elements; extent of computerization, benefits from it, and problems generated by it.

The initial problem, that of determining the degree to which computers have been employed in the accounting systems of the Navy, was the subject of Chapter II. Attempts at quantification of the current use of computers or the optimum use of computers met with frustration. A determination of the number of accounting activities or the number of computers in use would not be meaningful. The myriad of types of activities, computers, and appropriation makes the task of quantification too large for the time and scope restrictions of this project. The varying degrees of computerization between similar activities and between the various appropriations would greatly reduce the utility of quantification, even if it were possible.

In the attempt to define the optimum degree of computerization and the current level of progress toward that goal, the following conclusions have been reached:

(a) Confusion or disagreement over the appropriate orientation of the system is a source of problems within the Navy as well as industry.

(b) Civilian industry shows a greater concern for the internal financial management information needs as compared to external financial accounting than does the Navy.

(c) The facts that financial and operational information often are inseparable, and that operational information is computerized to a great degree indicate that further computerization of the accounting system is very likely. The ever increasing need for more timely and complete information for operational and management control tends to reinforce this trend.

(d) The accounting system is an integral subsystem of the total information system and should be treated as such rather than as a unique parallel system.

(e) Further computerization must continue to be judged by weighing the initial and operating costs of the system against the contribution the system makes to mission related objectives.

The second area to be studied in determining the impact of computerization was the subject of Chapter III, which involved a survey of the benefits expected. Two general categories of benefits were studied: (1) lower costs, and (2) better management.

The reduction of costs is generally to be attributed to the following factors:

(a) Reduction in the number of clerical personnel needed.

(b) Reduction in the number of required middle managers. (Cost savings in these two items assumes no expansion of the scope or quality of output expected. In practice, those savings usually have not materialized because the information needs, whether real or imagined, tend to keep pace with the greater capabilities which the computer affords.)

(c) Reduction in the need for hand annotation of documents and the attendant high error rate.

(d) Reduction in the number and duplication of files and the need for reconciliation.

(e) Reduction in the need for memorandum records to supplement the formal system information.

The contribution which the computer has made to better management is coming to be recognized as more important than the cost displacement benefits. Managers are increasingly more able to centralize the decision function to whatever degree the situation warrants. The recommendation of Haskins and Sells for greater centralization would not be possible were it not for the increased speed and capability of the computer.

The speed and extreme accuracy of electronic transmission of data between computer systems has permitted greater

organizational flexibility than was previously possible. The concept of area accounting centers have been implemented in some areas with varying degrees of success. The value of the concept is not to be debated here. The point is that the computer has made possible the evaluation of this and other potentially useful concepts.

The final area of research involved the problem currently being experienced as a result of computerization per se as well as secondary problems created. It was noted that the absence of a profit motive or competition in the public sector in general, and the Navy in particular, brings an additional dimension to the problem areas.

There is indeed a problem of communication between operating management and the computer specialist. The Navy's problems in this respect are identical to those in the civilian world. A greater awareness of each others special needs and broader education is advocated by most of the literature. The most promising approach for closing the gap is in intense cross-training of a few specialists from both fields.

Perhaps the greatest impact the computer has had, other than accelerating organizational change, is in the audit area. The depth of this impact can best be understood by a survey of the various audit techniques which have been developed. These techniques presume various degrees of technical knowledge of both the accounting and data processing fields as well as an appreciation for good management techniques.

The human factors involved in rapidly changing organization are of considerable magnitude. Although the computer is not the source of these problems it has intensified them as it has accelerated the possibilities and the need for changing the organization. Increased management awareness of these factors and their treatment is indicated. Finally, the impact on management requires a major re-thinking of traditional ways of doing business. Policy has to be made explicit for every decision point in the computer program. Human beings can tolerate ambiguous instructions by complementing the guidance with their own experience and ingenuity, the computer cannot.

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